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COMPLETE SPECIFICATION.

Improvements in and relating to Clutches Adapted for Use in Gear-Change Mechanisms.

I, MELVIN HARRY WOODWARD, a Citizen of the United States of America, of Margery Wood, Margery Lane, Lower Kingswood, Surrey, England, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention concerns improvements in and relating to clutches adapted for use in gear-change mechanisms, and in particular to an improved dental clutch therefor.

It is well known to connect a driving shaft, for instance the crankshaft of an automobile engine, to a driven shaft, such as the transmission shaft of the automobile, through a main clutch and a gear box, the gear box containing a plurality of gear trains of which only a selected one gear train is connected to the driven shaft at any particular time, a change of gear ratio being obtained when one gear train is disengaged and another gear train is selected and engaged in its stead. Before the selected gear train can be engaged with the driven shaft, that part of it (one element of a dental clutch) which is to be engaged with a co-operating element of the dental clutch which rotates with the driven shaft must be synchronised with the driven shaft, and it is well known to provide, for rotation with the respective elements of the dental clutch, two co-operating parts of a synchronising friction clutch which, just before the said dental clutch becomes engaged, engage one another and accelerate or decelerate the said one element of the dental clutch to synchronise it with the co-operating element. This acceleration or deceleration of the one

dental clutch element takes place whilst the main clutch is disengaged, and requires an appreciable interval of time since the inertia to be overcome by the synchronising clutch is that not only of the said one element of the dental clutch but of the whole gear train, extending back to the disengaged plate of the main clutch, which has been selected, and also of the disengaged main clutch plate itself and of the other gear trains rotated thereby. Reduction of the synchronising time interval, during which the main clutch must not be re-engaged, could only be achieved in such a known arrangement by increasing the size of the synchronising clutch and thereby increasing the torque which it can transmit from the driven shaft to the said one element of the dental clutch of the selected gear train.

It is an object of the present invention to provide an arrangement in which the inertia to be overcome by the synchronising clutch is minimised, thus permitting a more rapid gear change without requiring an enlargement of the synchronising clutch.

According to the invention, there is provided a dental clutch having two co-operating dental clutch elements which are rotatable independently of one another and mutually displaceable axially relative to one another for engagement and disengagement of the clutch, wherein one of the said dental clutch elements constitutes part of a free wheel device which also comprises a further free wheel element which can over-run the said one dental clutch element in one rotational direction and which is provided with longitudinal disposed teeth and with a first friction clutch element, and wherein there is provided, axially displaceable relative to the other of the said dental clutch elements

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and to the said further free-wheel element, a synchronising element which is provided with a second friction clutch element for engagement with the said first friction clutch element and which is in splined engagement with the said other dental clutch element, the said other dental clutch element being provided with longitudinally disposed splines which engage with the said synchronising element and which are also adapted to engage the teeth of the said further free wheel element.

Normally the said other dental clutch element and the said synchronising element will each be mounted on, and in longitudinal splined engagement with, a shaft for rotation therewith.

Conveniently, the said one dental clutch element is secured on, or otherwise in fixed relation with, a gear wheel which is freely rotatably mounted on the shaft, and the said further freewheel element is also freely rotatably mounted on the shaft.

Preferably the said other dental clutch element is of annular shape and encloses an annular space surrounding the said shaft, the said space being closed at one end by the said other dental clutch element and at the other end by the said synchronising element, the said synchronising element being in engagement with both the shaft and the said other dental clutch element, and there is provided on the shaft, at a longitudinally fixed position thereof, a reaction piston which engages the said other clutch element and divides the said annular space into two compartments, there being provided in communication with each of the two compartments a respective duct through which hydraulic fluid can be supplied thereto and exhausted therefrom.

A preferred embodiment of a dental clutch, and part of a transmission system, according to the invention is illustrated in the diagrammatic drawing accompanying the Provisional Specification.

In the drawing, a shaft 11 is to be driven from a motor or other driving means not shown. A gear wheel 12, which is mounted by means of a ball bearing 13 to be freely rotatable on the shaft, is provided with peripheral teeth for engagement direct or through a gear train (not shown) with a driven clutch plate of a main clutch (not shown) of which the driving plate is rotated by the driving means. Bolts 14 secure to the gear wheel 12 one part, an outer element 15, of a freewheel device of which a further, inner, element 16 is mounted by a roller bearing 17 for free rotation about the shaft 11. Between the freewheel outer and inner elements 15 and 16 are provided rollers or cams 18 of any known and suitable kind for the purpose, which, in one sense of rotation of the outer element 15,

cause the inner and outer elements to be locked together and to rotate as one. The inner and outer elements 15 and 16 are provided with teeth 19 and 20 and the inner element 16 is provided with a friction ring 21, constituting a first friction clutch element. The outer race 15 of the freewheel device constitutes, with its teeth 20, one element of a dental clutch.

The shaft 11 is formed with splines 22 and 23. The splines 22 are engaged by corresponding splines 24 of a synchronising element 25 which is provided with a second friction clutch element in the form of a friction ring 26, for engagement with the friction ring 21, and with outer splines 27. Surrounding the synchronising element 25 and the shaft 11 is a cylinder 28 which at one end is formed with splines 30 engaging the splines 23 of the shaft 11 and at its other end is formed with splines 29 engaging the splines 27 of the synchronising element 25. By this arrangement, the shaft 11, synchronising element 25 and cylinder 28 are constrained to rotate together but are permitted each to be displaced axially relative to the others. The generally annular cylinder 28 encloses an annular space, surrounding the shaft 11, which space is divided into two compartments 31 and 32 by a reaction piston 33, provided with a sealing ring 34 and secured against axial movement on the shaft 11 by two circlips 35. Bores 36 and 37 in the shaft 11 communicate with the compartments 31 and 32 respectively.

The teeth 19 and the splines 27 are compatible with one another, and the splines 29 are adapted to engage either with one or with both. The cylinder 28 is further provided with outer teeth 38 for engagement with the teeth 20, and constitutes the other element of the dental clutch of which one element is constituted by the outer race 15 of the freewheel device. It will be seen that the cylinder 28 can also engage the inner freewheel element 16 or both the elements 15 and 16 together. The synchronising element 25 and the friction rings 26 and 21 constitute a synchronising clutch for the inner freewheel element 16.

In explaining the operation of this embodiment of the invention, it will be assumed that the gear wheel 12 is rotated through a main clutch and one gear train of a gear box (not shown), by the driving means (not shown) in the clockwise direction as viewed from the left of the drawing. In accordance with this assumption the freewheel device which includes the elements 15 and 16 is arranged to permit the race 16 to rotate freely, in the clockwise direction, relative to the race 15. Now assume that the shaft 11 is already rotating at a certain speed in the clockwise direction, having been driven through another gear

train (not shown) which has just been disengaged, and assume that the said other gear train provided a higher gear than that obtained through the gear train with which the gearwheel 12 is in mesh. Then, if the driving means continues with the same speed of revolution as when the higher gear was engaged, it will be rotating the gear wheel 12, and hence the inner freewheel element 16 through the rollers or cams 18, at a slower rate than that at which the shaft 11 is rotating.

To clutch the gear wheel 12 to the shaft 11, hydraulic fluid under pressure is fed through the bore 36 into the compartment 31, the compartment 32 being open to exhaust. The fluid pressure acts immediately on the synchronising element 25, displacing it to the left in the drawing, so that the friction rings 26 and 21 engage one another, tending to accelerate the inner freewheel element 16 in the clockwise direction. Since the element 16 is free to rotate in this direction relative to the outer freewheel element 15, the inertia to be overcome by the synchronising element 25 is only that of the inner freewheel element 16, which thus very rapidly becomes synchronised with the element 25 and thus with the shaft 11 and the cylinder 28. The fluid pressure in the compartment 31 also acts on the cylinder 28 to displace it to the left, but due to the greater inertia of the cylinder 28 (as compared with that of the element 25) and to the smaller area it presents to the fluid pressure, it moves more slowly than the element 25. Accordingly, when the cylinder 28 has moved to the left sufficiently for its splines 29 to begin engaging the teeth 19 of the inner freewheel element 16, synchronisation of the inner element 16 with the element 25 has already taken place and engagement of the splines 29 and teeth 19 follows without difficulty. Whilst this engagement is taking place, the inner freewheel element 16 is overrunning the outer element 15, but as soon as the engagement has occurred, the driving means, and hence the gear wheel 12, are accelerated to rotate the freewheel elements 15 and 16 at increasingly nearly equal speed. On continued movement to the left of the cylinder 28, the teeth 38 engage the teeth 20, and the gear wheel 12 is then positively locked to the shaft 11 to prevent relative rotation in either direction. It will be noted that the only element which has been synchronised by the synchronising clutch is the freewheel inner element 16, all the other elements being synchronised by the power of the driving means as it is accelerated.

The foregoing explanation of the operation of the mechanism has been with reference to "changing down", when it is advantageous that transmission of power should be interrupted for as short a time as possible,

In fact, in changing down it is only necessary to disengage the main clutch for an instant to allow disengagement of the higher gear, so that the throttle may be held open without interruption. Application of fluid pressure in the compartment 31 is arranged to begin as the higher gear is disengaged, and engagement of the cylinder 28 and inner freewheel element 16 follows as described above during the interval which is required, after the main clutch has been re-engaged, for acceleration of the driving means, the flywheel, the main clutch and the gear wheel 12 to the increased speed at which they will have to rotate to prevent overrunning of the freewheel device. It may be desirable to disengage the main clutch briefly for a second time to allow the teeth 38 and 20 to engage one another easily whilst no torque is being transmitted through them. The whole gear change may, however, be effected without any throttling down of the driving means, because the interval or intervals during which the main clutch is disengaged are so short.

If the illustrated gear train is to be engaged after a lower gear has been engaged, it is of course, necessary to throttle the driving means in the normal manner, since in the new gear the driving means will initially be required to rotate more slowly than before the gear change. With a gear train of the kind illustrated, the driving means will be throttled down until its speed is slightly less than that required for synchronisation, so that briefly the freewheel device will overrun as in the case of changing down.

To disengage the illustrated gear train, the compartment 31 is opened to fluid exhaust through the bore 36, and the compartment 32 is placed in communication through the bore 37 with the source of hydraulic fluid under pressure. This causes the cylinder 28 to move to the right in the drawing, so that first the teeth 20 and then the teeth 19 are disengaged. Preferably the ring 25 is provided with a stop 39 which is engaged by the cylinder 28 which then draws the ring 25 to the right to disengage the friction rings 21 and 26 from one another.

It will be appreciated that for operation of the illustrated embodiment of the invention a source of hydraulic fluid under pressure is required as well as control means for connecting one of the bores 36 and 37 to the source and for simultaneously connecting the other to fluid exhaust. However, such control means are well known and understood by those skilled in the art and no further description thereof will be required in this Specification, except to note that for each of the plurality of selectable gear trains provided in a gear box there

will preferably be provided a dental clutch according to the invention and the control means will then be such that only one of the clutches can be actuated at any one time, each other such clutch being positively disengaged.

WHAT I CLAIM IS:—

1. A dental clutch having two co-operating dental clutch elements which are rotatable independently of one another and mutually displaceable axially relative to one another for engagement and disengagement of the clutch, wherein one of the said dental clutch elements constitutes part of a free-wheel device which also comprises a further free-wheel element which can overrun the said one dental clutch element in one rotational direction and which is provided with longitudinally disposed teeth and with a first friction clutch element, and wherein there is provided, axially displaceable relative to the other of the said dental clutch elements and to the said further free-wheel element, a synchronising element which is provided with a second friction clutch element for engagement with the said first friction clutch element and which is in splined engagement with the said other dental clutch element, the said other dental clutch element being provided with longitudinally disposed splines which engage with the said synchronising element and which are also adapted to engage the teeth of the said further free-wheel element.

2. A clutch element as claimed in Claim 1, wherein the said other dental clutch element is mounted on, and in longitudinal splined engagement with, a shaft for rotation therewith.

3. A clutch as claimed in Claim 2, wherein the synchronising element is mounted on, and in longitudinal splined engagement with, the said shaft for rotation therewith.

4. A clutch as claimed in Claim 2 or Claim 3, wherein the said other dental clutch element is of annular shape and encloses an annular space surrounding the said shaft, the said space being closed at one end by the said other dental clutch element and at the other end by the said synchronising element, the said synchronising element being in engagement with both the shaft and the said other dental clutch element, and wherein there is provided on the shaft, at a longitudinally fixed position thereof, a reaction piston which engages the said other dental clutch element and divides the said annular space into two compartments, there being provided in communication with each of the two compartments a respective duct through which hydraulic fluid can be supplied thereto and exhausted therefrom.

5. A clutch as claimed in any of Claims 2, 3 and 4, wherein the said further free-wheel element is freely rotatably mounted on the said shaft.

6. A clutch as claimed in any of Claims 2 to 5, wherein the said one dental clutch element is positioned fixedly relative to a gearwheel which is freely rotatably mounted on the said shaft.

7. A clutch as claimed in any of the preceding claims, wherein the said one dental clutch element is the final element of one of a plurality of gear trains comprised by a gearbox.

8. A dental clutch substantially as described herein with reference to the drawing accompanying the Provisional Specification.

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PROVISIONAL SPECIFICATION.

Improvements in and relating to Clutches Adapted for Use in Gear-Change Mechanisms.

I, MELVIN HARRY WOODWARD, a Citizen of the United States of America, of Margery Wood, Margery Lane, Lower Kingswood, Surrey, England, do hereby declare this invention to be described in the following statement:—

The present invention concerns improvements in and relating to gear-change mechanisms.

It is well known to connect a driving shaft, for instance the crankshaft of an auto-

mobile engine, to a driven shaft such as the transmission shaft of the automobile, through a main clutch and a gear box, the gear box containing a plurality of gear trains of which only a selected one gear train is connected to the driven shaft at any particular time, a change of gear ratio being obtained when one gear train is disengaged and another gear train is selected and engaged in its stead. Before the selected gear train can be engaged with the driven shaft, that part of it (one element of a dental

clutch) which is to be engaged with a co-operating element of the dental clutch secured on the driven shaft must be synchronised with the driven shaft, and it is well known to provide, for rotation with the respective elements of the dental clutch, two co-operating parts of a synchronising friction brake which, just before the said dental clutch becomes engaged, engage one another and accelerate or decelerate the said one element of the dental clutch to synchronise it with the co-operating element. This acceleration or deceleration of the dental clutch element takes place whilst the main clutch is disengaged, and requires an appreciable interval of time since the inertia to be overcome by the synchronising brake is that not only of the said one element of the dental clutch but of the whole gear train, extending back to the disengaged plate of the main clutch, which has been selected, and also of the disengaged main clutch plate itself and of the other gear trains rotated thereby. Reduction of the synchronising time interval, during which the main clutch must not be re-engaged, could only be achieved in such a known arrangement by increasing the size of the synchronising brake and thereby increasing the torque which it can transmit from the driven shaft to the said one element of the dental clutch of the selected gear train.

It is an object of the present invention to provide an arrangement in which the inertia to be overcome by the synchronising brake is minimised, thus permitting a more rapid gear change without requiring an enlargement of the synchronising brake.

An embodiment of a transmission system according to the invention is shown in part (only one of an assumed plurality of selectable gear trains being illustrated) in the accompanying diagrammatic drawing.

In the drawing, a shaft 11 is the shaft to be driven from a motor or other driving means not shown. A gear wheel 12, which is mounted by means of a ball bearing 13 to be freely rotatable on the shaft, is provided with peripheral teeth for engagement direct or through a gear train not shown with a driven clutch plate of a main clutch (not shown) of which the driving plate is rotated by the driving means. Bolts 14 secure to the gear wheel 12 an outer race 15 of a freewheel device of which an inner race 16 is mounted by a roller bearing 17 for free rotation about the shaft 11. Between the freewheel outer and inner races 15 and 16 are provided rollers or cams 18 which, in one sense of rotation of the outer race 15, cause the inner and outer races to be locked together and to rotate as one. The inner and outer races 15 and 16 are provided with teeth 19 and 20 and the inner race 16 is provided with a friction ring 21.

The shaft 11 is formed with splines 22 and 23. The splines 22 are engaged by corresponding splines 24 of a ring 25 which is provided with a friction ring 26, for engagement with the friction ring 21, and with outer splines 27. Surrounding the ring 25 and the shaft 11 is a cylinder 28 which at one end is formed with splines 29 engaging the splines 27 of the ring 25 and at its other end is formed with splines 30 engaging the splines 23 of the shaft 11. By this arrangement, the shaft 11, ring 25 and cylinder 28 are constrained to rotate together but are permitted each to be displaced axially relative to the others. The interior of the cylinder 28 is divided into two compartments 31 and 32 by a reactor piston 33, provided with a sealing ring 34 and secured axially on the shaft 11 by two circlips 35. Bores 36 and 37 in the shaft 11 communicate with the compartments 31 and 32 respectively.

The teeth 19 and the splines 27 are compatible with one another, and the splines 29 are adapted to engage either with one or with both. The cylinder 28 is further provided with outer teeth 38 for engagement with the teeth 20. Thus the cylinder 28 is one element of a dental clutch of which the other element is the inner race 16 or the outer race 15 or both the races 15 and 16 together. The ring 25 and the friction rings 26 and 21 constitute a synchronising brake for the inner race 16.

In explaining the operation of this embodiment of the invention, it will be assumed that the gear wheel 12 is rotated by the driving means (not shown) in the clockwise direction as viewed from the left of the drawing. In accordance with this assumption, the freewheel device which includes the races 15 and 16 is arranged to permit the race 16 to rotate freely, in the clockwise direction, relative to the race 15. Now assume that the shaft 11 is already rotating at a certain speed in the clockwise direction, having been driven through another gear train (not shown) which has just been disengaged, and assume that the said other gear was a higher gear than the gear illustrated. Then, if the driving means continues with the same speed of revolution as when the higher gear was engaged, it will be rotating the gear wheel 12, and hence the inner race 16 through the rollers or cams 18, at a slower rate than the shaft 11 is rotating.

To clutch the gear wheel 12 to the shaft 11, hydraulic fluid under pressure is fed through the bore 36 into the compartment 31, the compartment 32 being open to exhaust. The fluid pressure acts immediately on the ring 25, displacing it to the left in the drawing, so that the friction rings 26 and 21 engage one another, tending to

accelerate the inner race 16 in the clockwise direction. Since the race 16 is free to rotate in this direction relative to the outer race 15, the inertia to be overcome by the synchronising clutch is only that of the inner race 16, which thus very rapidly becomes synchronised with the ring 25 and thus with the shaft 11 and the cylinder 28. The fluid pressure in the compartment 31 also acts on the cylinder 28 to displace it to the left, but due to the greater inertia of the cylinder 28 (as compared with that of the ring 25) and to the smaller area it presents to the fluid pressure, it moves more slowly than the ring 25. Accordingly, when the cylinder 28 has moved to the left sufficiently for its splines 29 to begin engaging the teeth 19 of the inner race 16, synchronisation has already taken place and engagement of the splines 29 and teeth 19 follows without difficulty. Whilst this engagement is taking place, the inner race 16 is overrunning the outer race 15, but as soon as the engagement has occurred, the driving means, and hence the gear wheel 12, are accelerated to rotate the races 15 and 16 at increasingly nearly equal speed. On continued movement to the left of the cylinder 28, the teeth 38 engage the teeth 20, and the gear wheel 2 is then positively locked to the shaft 11 to prevent relative rotation in either direction. It will be noted that the only element which has been synchronised by the synchronising brake is the race 16, all the other elements being synchronised by the power of the driving means as it is accelerated.

The foregoing explanation of the operation of the mechanism has been with reference to "changing down", when it is advantageous that transmission of power should be interrupted for as short a time as possible. In fact, in changing down it is only necessary to disengage the main clutch for an instant to allow disengagement of the higher gear, so that the throttle may be held open without interruption. Application of fluid pressure in the compartment 31 begins as the higher gear is disengaged, and engagement of the cylinder 28 and inner

race 16 follows as described above during the interval which is required, after the main clutch has been re-engaged, for acceleration of the driving means the flywheel, the main clutch and the gear wheel 2 to the increased speed at which they will have to rotate to prevent overrunning of the freewheel device. It may be desirable to disengage the main clutch briefly for a second time to allow the teeth 38 and 20 to engage one another. The whole gear change may, however, be effected without any throttling down of the driving means, because the interval or intervals during which the main clutch is disengaged are so short.

If the illustrated gear train is to be engaged after a lower gear has been engaged, it is of course, necessary to throttle the driving means in the normal manner, since in the new gear the driving means will initially be required to rotate more slowly than before the gear change. With a gear train of the kind illustrated, the driving means will be throttled down until its speed is slightly less than that required for synchronisation, so that briefly the freewheel device will overrun as in the case of changing down.

To disengage the illustrated gear train, the compartment 31 is opened to fluid exhaust through the bore 36, and the compartment 32 is placed in communication through the bore 37 with the source of hydraulic fluid under pressure. This causes the cylinder 28 to move to the right in the drawing, so that first the teeth 20 and then the teeth 19 are disengaged. Preferably the ring 25 is provided with a stop 39 which is engaged by the cylinder 28 which then draws the ring 25 to the right to disengage the friction rings 21 and 26 from one another.

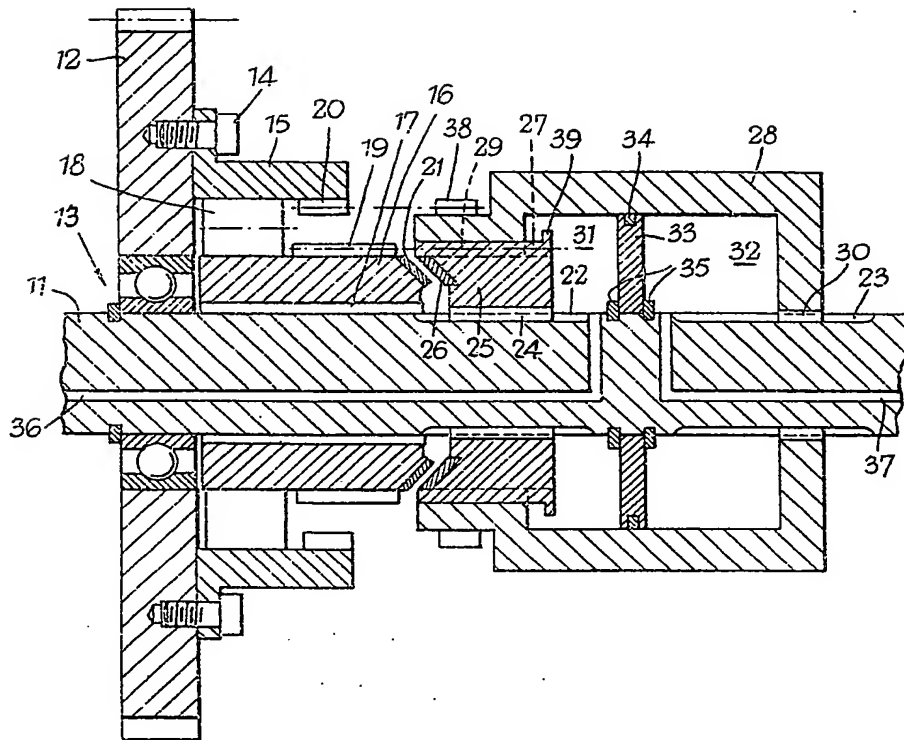
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1 SHEET

PROVISIONAL SPECIFICATION

This drawing is a reproduction of the Original on a reduced scale.



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